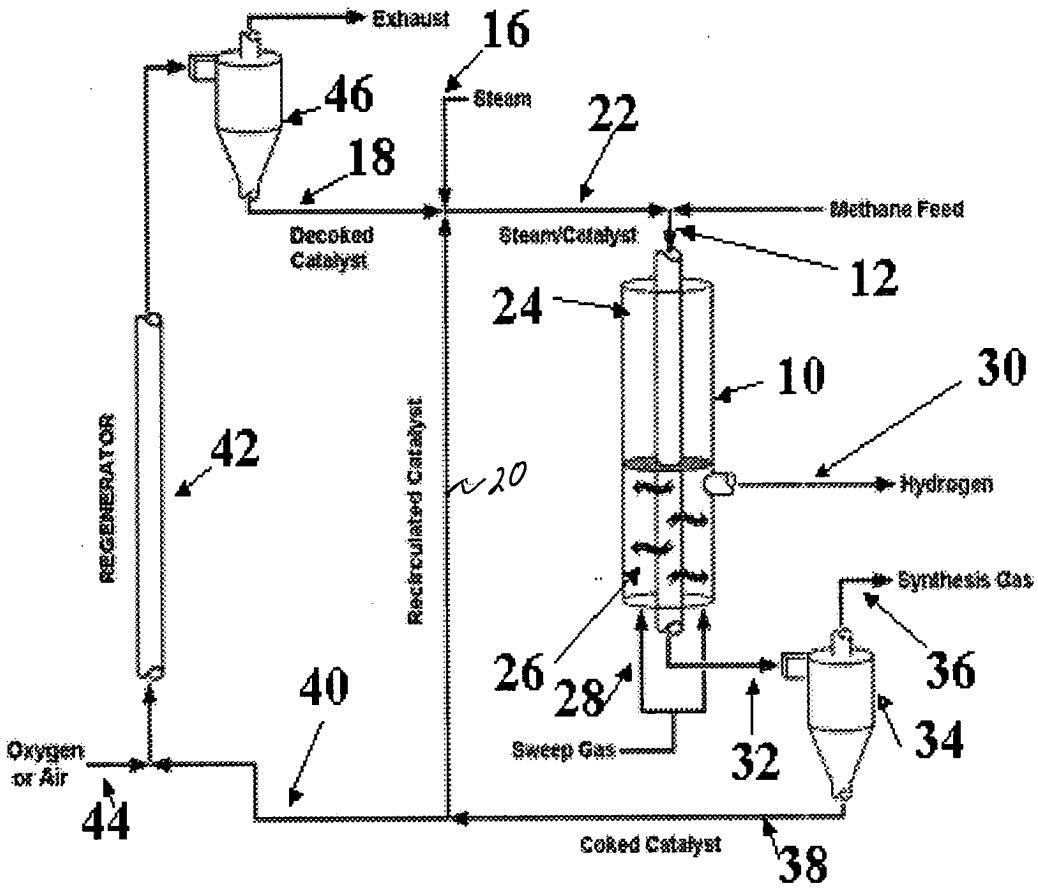

Exhaust
16
Steam
46
18
22
Methane Feed
Decoked Catalyst
Steam/Catalyst
12
24
10
30
42
REGENERATOR
Recirculated Catalyst
~20
Hydrogen
Synthesis Gas
26
28
36
40
Sweep Gas
32
34
Oxygen or Air
44
Coked Catalyst
38

Figure 1

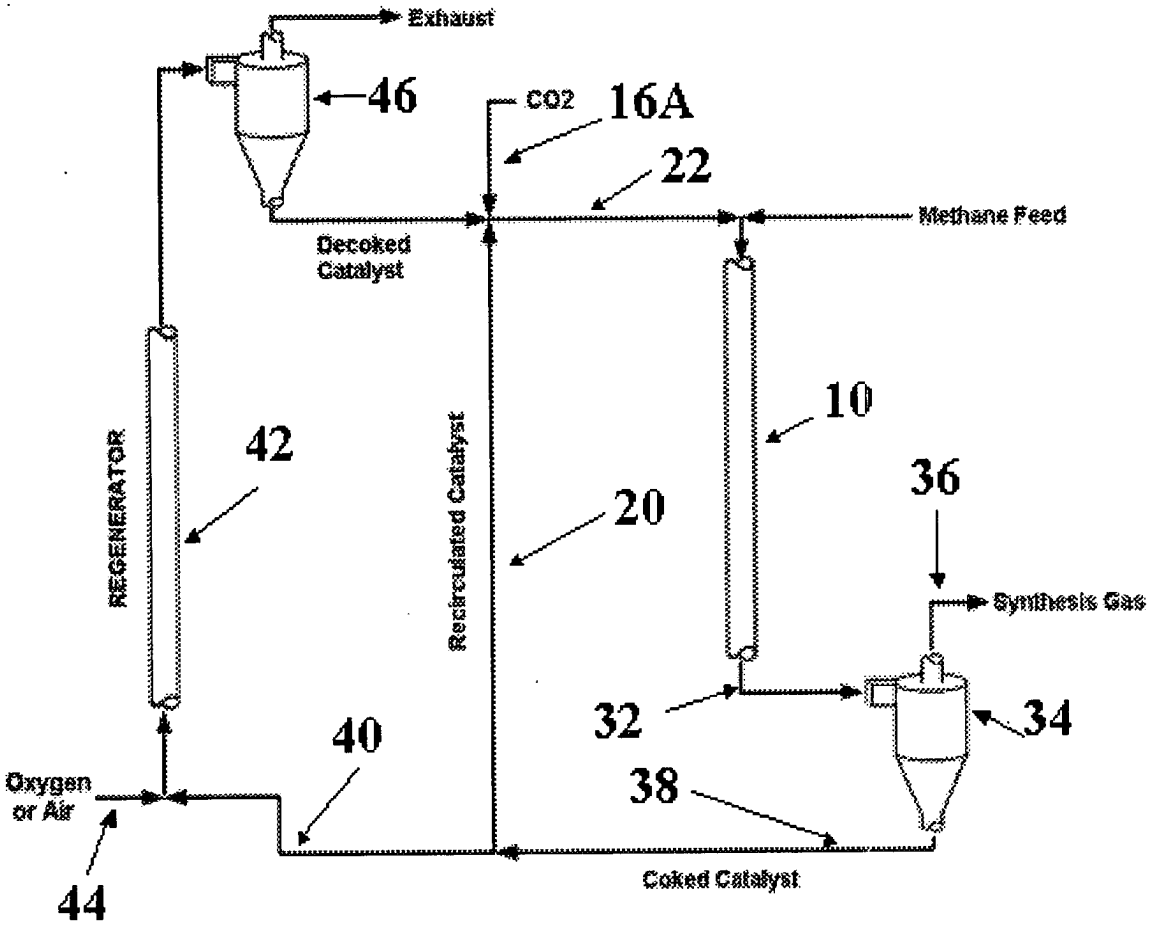
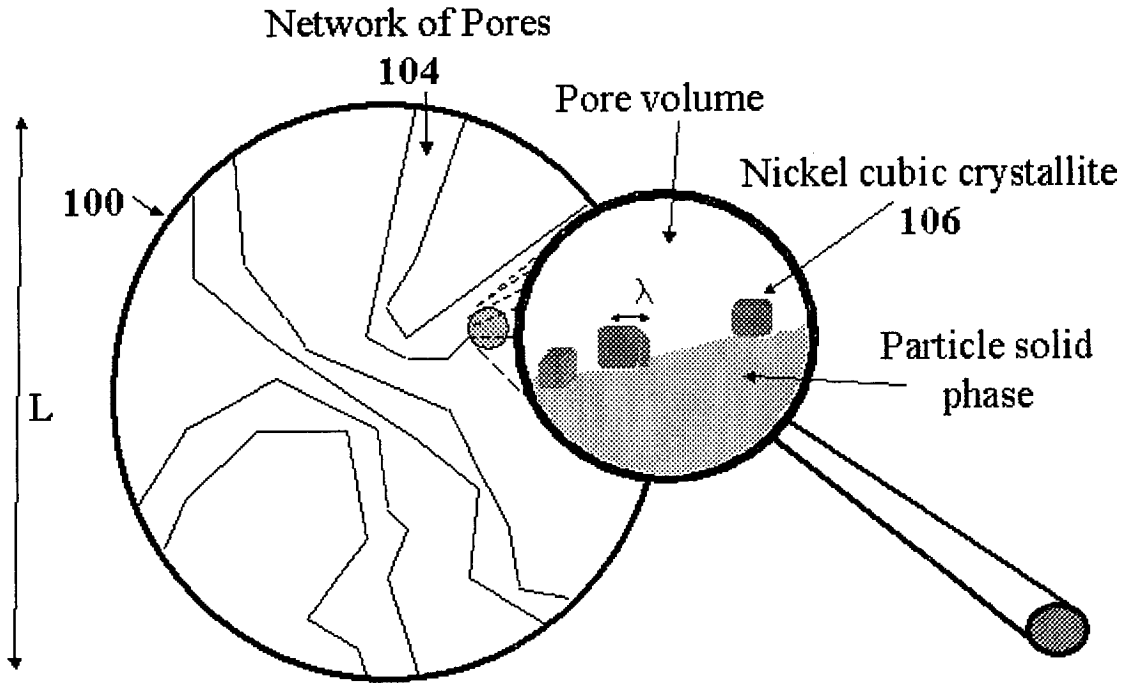

Exhaust
46
CO2
16A
22
Methane Feed
Decoked
Catalyst
10
42
REGENERATOR
Recirculated Catalyst
20
36
Synthesis Gas
32
34
40
38
Oxygen
or Air
44
Coked Catalyst

Figure 2



Enlarged view of inner particle surface

Figure 3

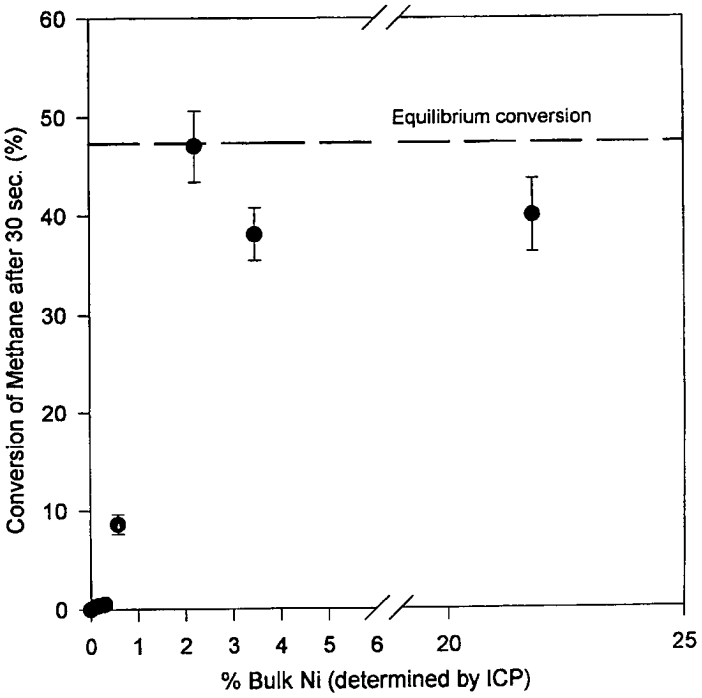
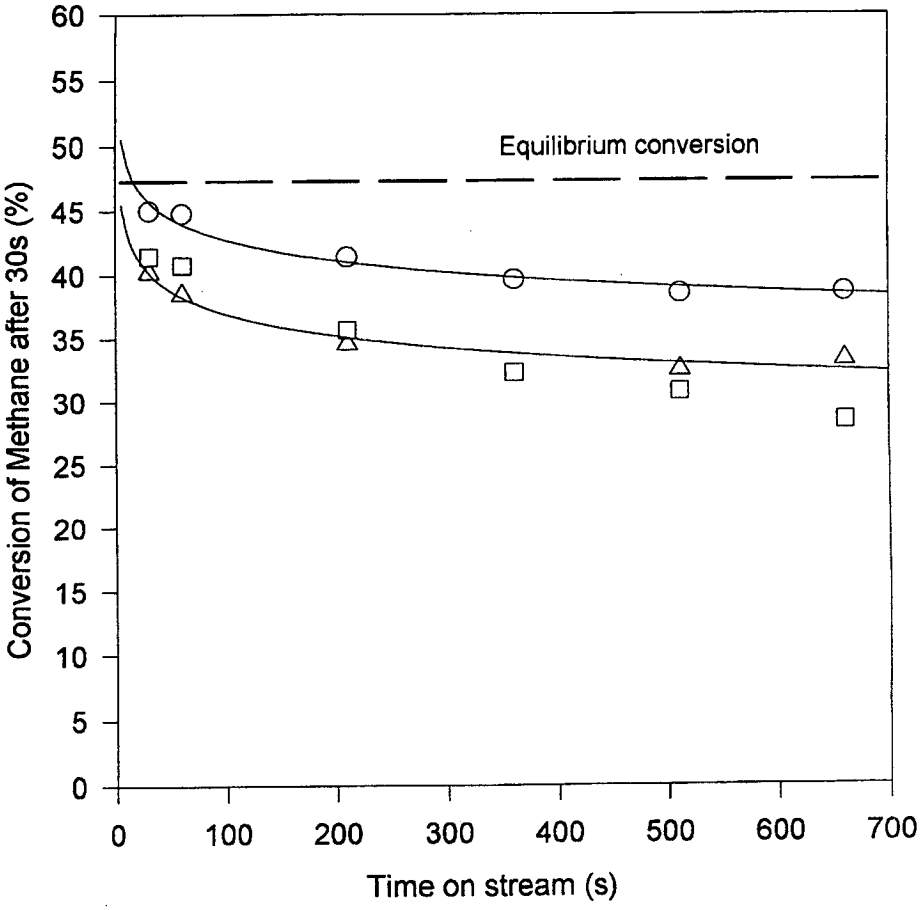

60
50
40
30
20
10
0
Conversion of Methane after 30 sec. (%)
Equilibrium conversion
0
1
2
3
4
5
6
20
25
% Bulk Ni (determined by ICP)

Figure 4



□ **Crystal size=179 A, Dispersion=0.14 m^2Ni/m^2support**
□ **Crystal size= 529 A, Dispersion=0.058 m^2Ni/m^2support**
□ **Crystal size=1929 A, Dispersion=0.04 m^2Ni/m^2support**

Figure 5

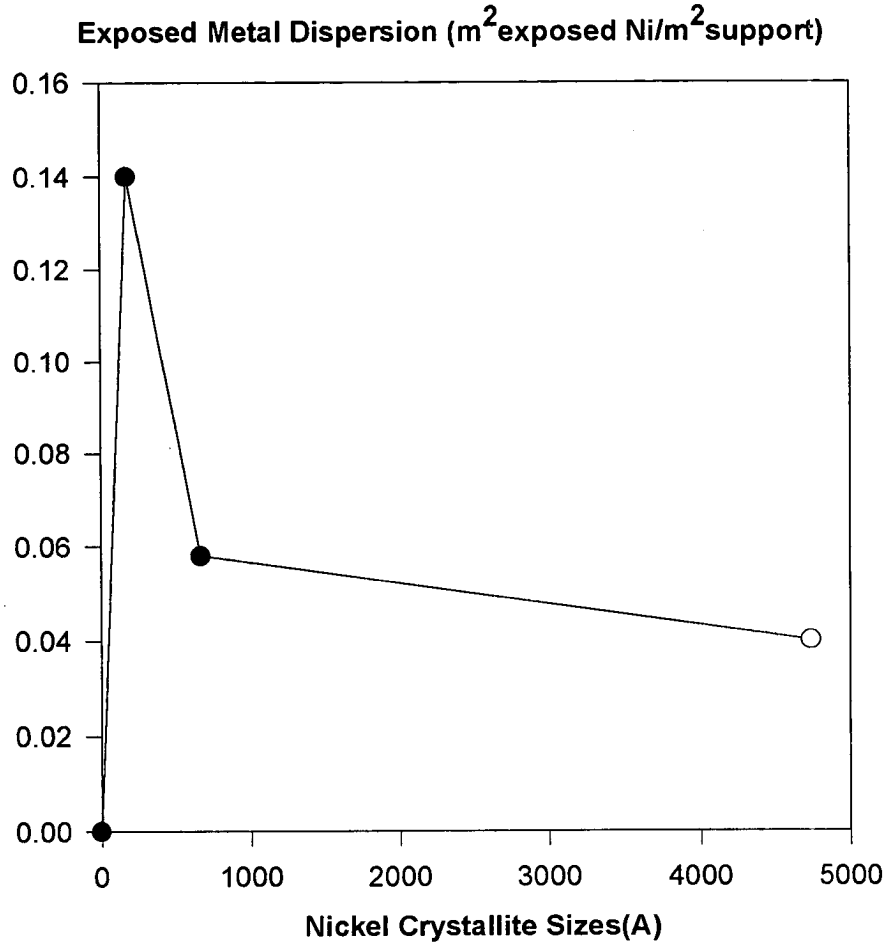
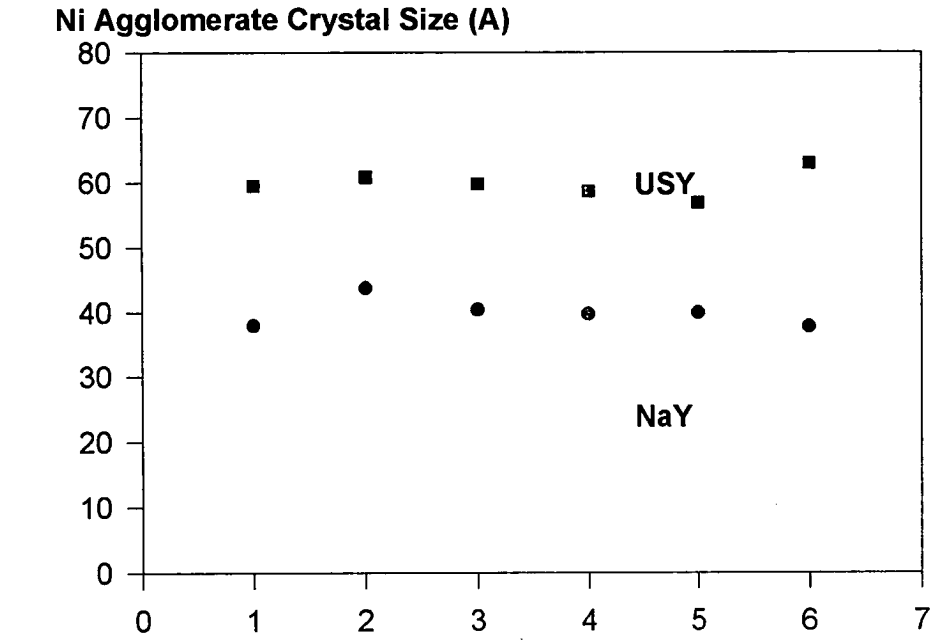

Exposed Metal Dispersion (m2exposed Ni/m2support)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
1000
2000
3000
4000
5000
Nickel Crystallite Sizes(A)

Figure 6


Ni Agglomerate Crystal Size (A)
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
USY
NaY

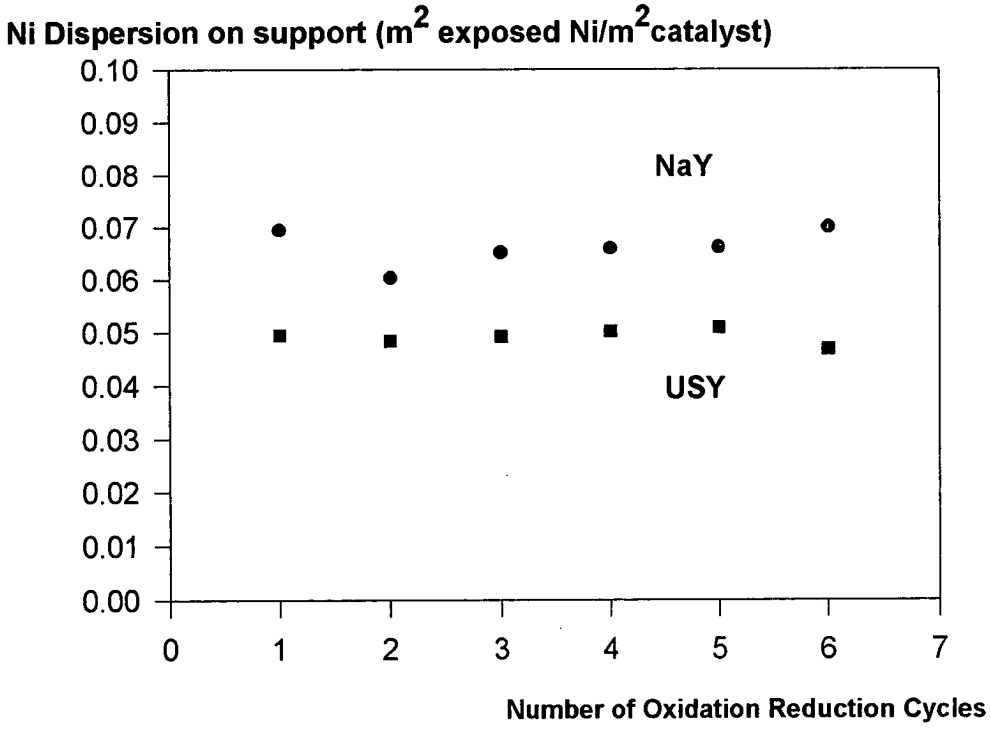
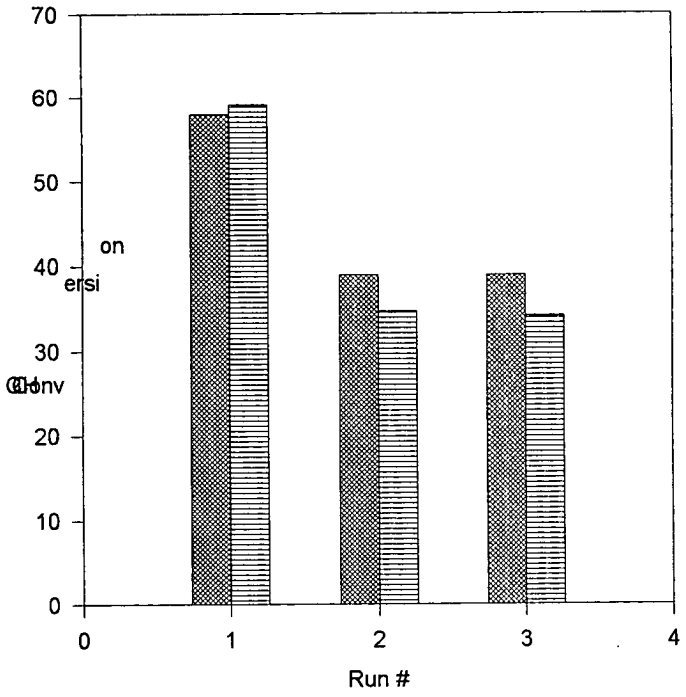

Ni Dispersion on support (m2 exposed Ni/m2catalyst)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
1
2
3
4
5
6
7
NaY
USY
Number of Oxidation Reduction Cycles

Figure 7



1. **USY, Crystal size=40A, Dispersion=0.05 m^2Ni/m^2support; T=750 C, 60 psi, 40 s.**
2. **USY, Crystal size=40A, Dispersion=0.05 m^2Ni/m^2support; T=750 C, 95 psi, 15s.**
3. **USY, Crystal size=40A, Dispersion=0.05 m^2Ni/m^2support; T=750 C, 92 psi, 15s.**

Note: Dry reforming of methane using USY zeolites. The left hand side bars represent chemical equilibrium values the right hand side bars the actual methane conversion values in the riser simulator. Note that the CH4/CO2 ratios for all these runs are 1.

Figure 8